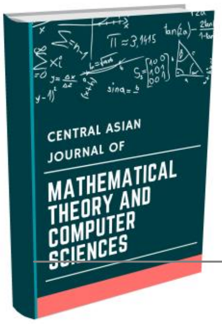

CENTRAL ASIAN JOURNAL OF MATHEMATICAL THEORY AND COMPUTER SCIENCES

https://cajmtcs.centralasianstudies.org

Volume: 03 Issue: 07 | July 2022 **ISSN: 2660-5309**

A THOROUGH REVIEW OF WSN ROUTING PROTOCOLS

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Annotation

In simple terms, a Wireless Sensor Network (WSN) is a dispersed network made up of nodes. Sensor nodes or motes are the more prevalent names for these nodes. In order to comprehend the issues with WSN, a complete analysis of the current protocols is accomplished. The sensor is a consistently dispersed, restriction-free device that uses energy from a finite supply. Numerous novel routing protocols have been developed expressly for wireless sensor networks, where energy awareness is a key design consideration. The routing protocols have received the majority of attention because they might vary according to the application and network design. The characteristics of WSNs are discussed in this study. The following section of this study investigates current routing methods for wireless sensor networks, classifies them, and contrasts and compares some of the leading routing protocols.

ARTICLEINFO

Article history:
Received 28 may 2022
Revised form 25 june 2022
Accepted 19 july 2022

Key words: *WSN, Routing protocols, Base Station (BS).*

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INTRODUCTION:

The WSN is a dispersed network of source-constrained, minute nodes capable of operating with little user involvement [1]. Micro electromagnetic systems (MEMS) technology has advanced quickly, resulting in tiny, inexpensive sensor motes that can sense a wide range of physical and environmental conditions. The WSN improves people's capacity to track and control physical sites from a distance [2]. The failure of a few sensors does not impact the working of the entire structure because each sensor node can operate independently without any central management [3]. The WSN is more dependable and secure than other

kinds of networks. All nodes are armed with a CPU, storage, a source of power, a transceiver, actuators, and one or more limited energy sensors [4]. WSN and its components are shown in Fig 1:

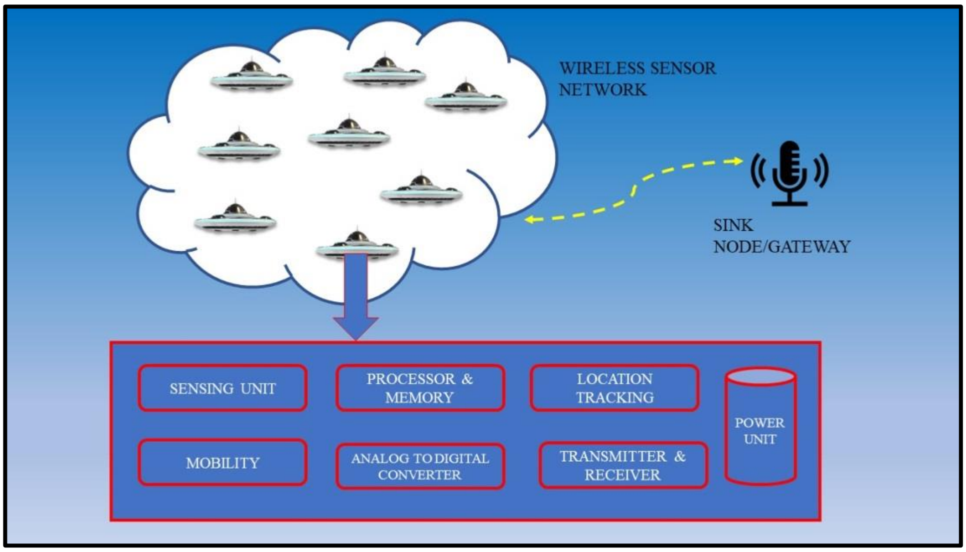

Fig 1: WSN and its Components

WSN techniques must address a variety of difficulties and design problems. Despite technological improvement, sensor nodes in WSNs still face limitations such as low battery power, bandwidth limits, low processing power, and little memory. Because of this, routing systems must be highly adaptable and resource conscious. Fig 2 provides a complete classification of WSN routing protocols.

RELATED WORK:

There are two types of WSN based on setup: unorganized and organized. Nodes in organized WSN are planned and scheduled, whereas nodes in unorganized WSN are placed at random. Unorganized networks have a fixed number of controllable sensors while organized networks typically have a tight organization and sophisticated administration [5]. Energy maintenance in these kinds of WSN becomes extremely difficult because in far locations. It is impossible to repair or renew a node's power-source [6]. The WSN is utilized across a wide range of industries, including the military, agriculture, manufacturing, item tracing, demographics, global defense, surveillance disaster-prone areas, trade transactions, medical services, personal protection, and ecological readings. Due to limited power, the WSN faces the problem of energy holes [7].

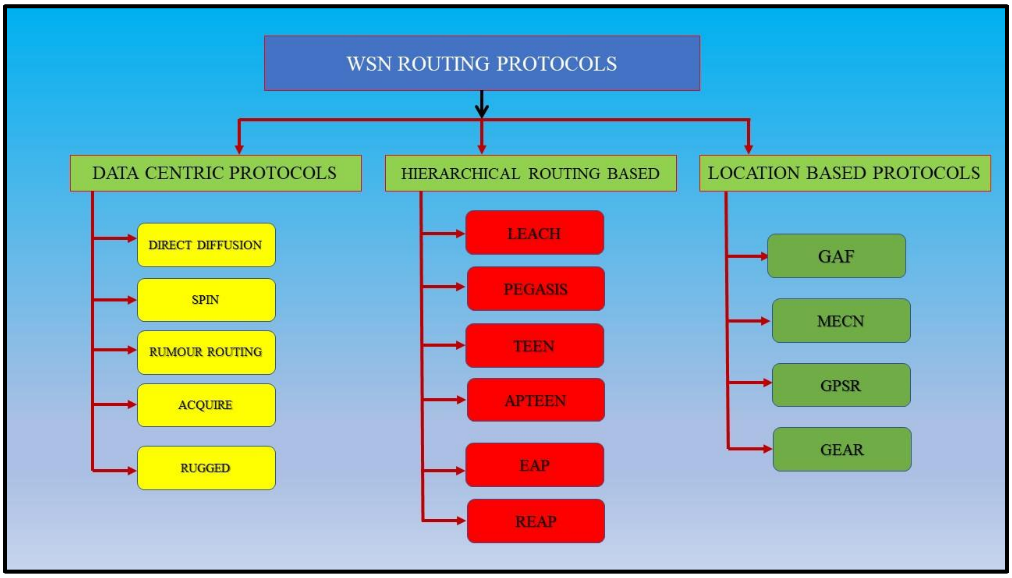

Fig 2: Complete Classification of WSN Protocols

1. DATA-CENTRIC PROTOCOLS

It is impossible to give each sensor node a unique global identity due to the widespread deployment of sensor nodes. As a result, query-based routing methods known as data-centric routing protocols were created. In a query-based network, the base station sends a query to a specific area of the network where it needs data. The base station sends the query to a random sensor node, which then has to pass it to the correct area. Assembling the information, they have gathered, the sensor nodes in the area return to the base station via the reverse direction deduced in the earlier stage.

SPIN (Sensor Protocols for Information via Negotiation)

The SPIN, which was designed specifically for WSNs and bears various resemblances for straight dispersal, is the premier data-based protocol. It is adept at reducing excess information and preserving battery life [8]. The key factor contributing to the formation of the SPIN is the dissemination of data (figure 3). In the WSN, where each node is regarded as a BS, it is the practice of compiling the clarifications of the entire class of various motes that are implanted. These nodes' task is to collect detailed knowledge about the area as packets are transmitted and to provide a fault-free network configuration. To improve the permanence interval of the node in the network, power depletion in calculation and communication should be controlled.

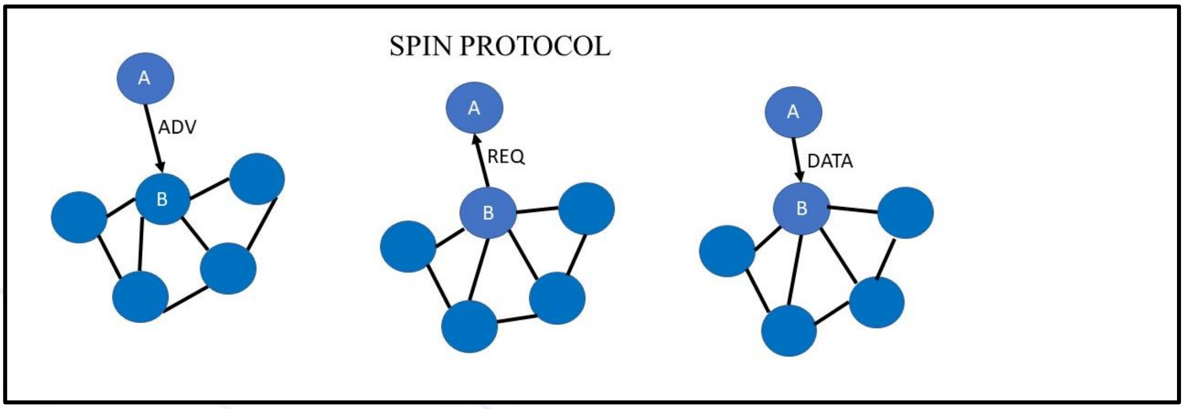

Fig 3: Functioning of SPIN Protocol

Direct Diffusion

A data-centric, query-based, and application-aware protocol called direct diffusion[9] performs data aggregation at each network node. All data created by sensor network is named by attribute-value pairs, and the nodes won't disclose the sensed data until the sink node requests it. The changes in the sensed data are the events produced by a single node or a collection of nodes. As an attraction for identified data, the interest inquiries are broadcast throughout the sensor network. The network's gradients were set up to draw events as a result of this dissemination. Each node that receives an interest creates a gradient, which is a direction state. The node inside the event region transmits the observed data events back to the BS over several gradient paths. The BS transmits interest messages on a periodic basis for each active task. The interval will be significantly larger in the initial message used to set up the gradients for retrieving the data. Every node in the network keeps an interest cache with data on the interest that has been received. The knowledge about the one-hop neighbor from whom the interest was received is stored in the interest cache. When a node receives an interest, it first determines whether it already appears in the interest caching. If there isn't a matching entry in the interest cache, the node generates one and stores the interest's details in it. The timestamp and expires on variables are changed if the item already exists, and the node then sends the interest to all of its neighbors.

Rumor Routing

Rumor routing[10] directs the requests to network events and provides a trade-off between setup time and delivery dependability. An event is an abstraction created from a collection of sensor readings that is believed to represent a localized occurrence in a specific area of the network. A query is a request for data that is issued by the base station, and once the data has been collected, it can start to flow back to the source

of the inquiry. It is wise to invest in finding the quickest path from source to sink if there is a substantial amount of data to send. Many techniques, including directed diffusion, are inefficient in terms of energy use since they only use query flooding until they reach the event location. However, methods like rumour routing employ an improved flooding strategy, which increases their energy efficiency. A natural middle ground between flooding queries and flooding event alerts is rumour routing. While event flooding generates a gradient field throughout the whole network, the objective is to establish pathways leading to each event.

ACQUIRE (Active Query forwarding In Sensor Networks)

The foundation of ACQUIRE [11] is the idea that a query is an active query that is sent through the network in search of a solution. The query is partially resolved at each node by forwarding it utilizing the data from all nodes within d hops. A response is produced and sent back to the querier at the node where the query is fully resolved.

RUGGED (Gradient based routing)

Any physical event that takes place in the environment produces a natural gradient of information close to the phenomena. This information gradient is referred to as the event's digital fingerprint. The RUGGED[12] protocol effectively uses the event's fingerprint to redirect the query to the event. Additionally, most physical processes obey the diffusion equation as distance increases. It avoids the burden of creating and preserving the gradient information, in contrast to other knowledge procedures.

2. HIERARCHICAL ROUTING TECHNIQUES

The process of placing routers in a hierarchical order is called hierarchical routing. With a hierarchical protocol, an operator can use his quick, strong routers as the backbone routers while still allowing access to the slow, lower-powered routers. In this architecture, the access routers make up the first layer and the backbone routers the second. In an effort to keep local traffic local, hierarchical protocols won't transfer traffic to the backbone unless it's absolutely required to get there.

LEACH

The LEACH protocol reduces the amount of communication energy lost by the CHs and cluster members by almost eight times, in contrast to direct transmission and least transmission power routing [13]. LEACH has the lowest latency of all protocols. It also maintains a significant degree of extensibility because sensors can easily change variations, such as adding additional nodes to the WSN, and they can start functioning as cluster members thanks to signals by CHs. With the establishment of clusters, it becomes more energy-efficient because only CHs are capable of transmitting data and all the sensors follow a randomized alternative to become CHs. It has a poor QoS aspect and has a very small memory reservoir dimension because of resource limitations, such as limited processing. Because all nodes in the WSN keeps changing the areas, we are unable to forecast the traffic pattern.

PEGASIS (Power Efficient Gathering in Sensor Information System)

All packets in PEGASIS [14] must traverse the chain in order to reach the BS, which results in a significant amount of latency. Any important information that needs to be conveyed immediately must go through the entire chain, whether it comes from the last or the first sensor. Since the transmission path is not static, freshly deployed nodes can be quickly added to the chain. A alternative node that retains a lot more energy has also been connected to the chain. The PEGASIS has increased energy awareness to reach the destination, which is significantly extra powerful than the cluster setup, thanks to the development of chain topology. Since every sensor that makes up the chain is the only new node that may forward, only the node that is closest to the destination is in charge of transmission, a tiny overhead has been noticed in the network. Due to the data transmission interruption and the lack of processing power, each node combines a little amount of data with the data packet while indorsing to other nodes along the chain, resulting in a low QoS factor. Data loss can be caused by a variety of network instability, including node failure, link failure, and power outages.

TEEN (Threshold sensitive energy efficient protocols)

The two threshold-sensitive hierarchical routing protocols based on the clustering method employed in LEACH are Threshold Sensitive Energy Efficient Protocol (TEEN) and Adaptive Threshold Sensitive Energy Efficient Protocol (APTEEN) [15]. TEEN and APTEEN are intended at reactive network applications, while LEACH is targeted at proactive network applications. In a pro-active network, sensed data is routinely transferred to the sink, which then periodically delivers a snapshot of pertinent parameters. Reactive networks respond instantly to a rapidly changing in sensed input and send the information to the sink. Since they spend the majority of the time sleeping, there are fewer transmissions, which means less energy is used.

EAP (Energy Aware routing Protocol)

EAP [16] is a hierarchical cluster-based protocol that minimizes energy consumption for in-network communication and evenly distributes energy burden across all nodes to obtain excellent throughout. It also implements an effective technique termed as the intra cluster covering, which addresses the area coverage issue. It offers a new clustering variable for cluster head selection that allows good management of diverse energy capabilities.

REAP (Ring based Energy Adaptive Protocol)

The nodes self-organize in virtual ring bands around the BS in REAP [17]. Deliveries of packets to the BS follow a route with a decreasing ring band number. Additionally, a probabilistic forwarding strategy balances the burden of nearby nodes within the same ring band. Flooding is used less frequently by REAP, which saves a lot of energy. Finally, because it does not necessitate establishing and maintaining routing tables, REAP is resilient against node failures. These REAP capabilities effectively extend the network lifetime.

3. LOCATION BASED ROUTING PROTOCOLS

An essential area of study in the WSN is routing algorithms based on location. They use geo location information to direct packet routing, routing identification, and management, allowing the best routing to be chosen, lowering energy use, and improving the entire network. The significance of location information in the routing algorithm is demonstrated by three factors including the flooding restriction scheme, the virtual area division method, and the optimal routing choice scheme.

GAF (Geographic Adaptive Fidelity)

As per GAF, there is good stability because the nodes are perfectly placed in the WSN and used there [18]. Every node uses a location recognizer to locate itself. All of the nodes in GAF are arranged using virtual grids. The nodes that belong to the same grid position group together to view the sleep schedule. One node cannot get overburdened by unneeded workload because load balancing has been done. Identification, active, and sleeping are the three basic transition phases seen in GAF. Each sensor starts out in the detection status, where it turns on its circuit and starts sending discovery MSG to find other adjacent nodes in the same grid. All detected MSG consists of a collection of identifiable elements, such as node condition, node ID, and grid ID, Fig 4. Massive amounts of data arrives from the (randomly positioned) nodes to the destination using the location-centered routing protocol GAF. The GAF employs a system to transmit the perceived knowledge to the destination after using a GPS positioning method to identify all adjacent neighbors. The GAF excels at object tracking via low energy in the network by gathering position information, and does so while appropriately lengthening the lifespan of the WSN. As the WSN's scalability is stationary, GAF exhibits improved enactment when utilized in observation applications since it causes a little amount of WSN delay and produces speedier results. As there is no surplus route, if a packet is damaged, or if the node is unable to determine the optimum route and becomes an energy hole, the QoS feature is minimal in this case.

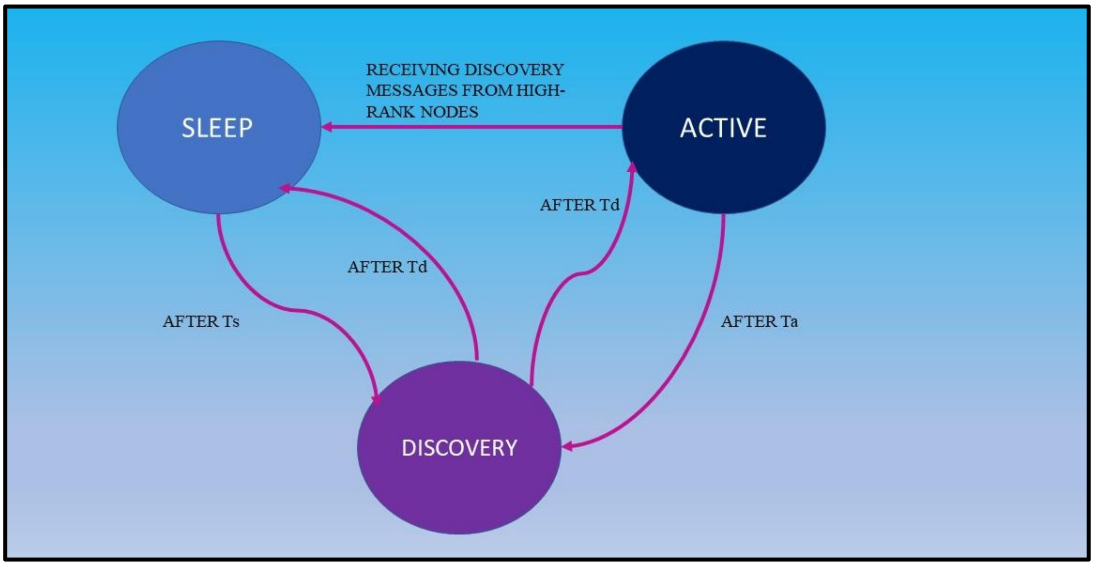

Fig4: Working of GAF

MECN (Minimum Energy Communication Network)

A location-based routing protocol is MECN [18]. By leveraging low power GPS, it maintains a minimum energy network for wireless networks. Although this protocol can be applied to mobile networks, sensor networks are where it excels. This is due to the immobility of sensor networks. For stationary nodes, a master node is added to a minimum power topology. For sensor networks, a master site is always taken into account as the information sink.

GPSR (Greedy Perimeter Stateless Routing)

The GPSR [19] is a routing protocol that bases packet forwarding decisions for WSNs on the location of routers and packet destinations. The decision to forward a packet, or to move it from one node to another target node via the shortest path possible, is made by GPSR. Consequently, the word "greedy" is related to the routing protocol. The knowledge of a router's close neighbors in the network topology is used to decide whether to forward a packet greedily. When a packet enters an area where greedy forwarding is not possible, routing around the region's edge is the alternate action. Mobility causes the topology to change frequently, yet the GPSR protocol uses the local topology knowledge to quickly establish reliable new routes. The speed of topology modification and the total number of routers in the routing domain are two key determinants of the GPSR routing protocol's capacity to scale. The goal of scalability is to expand the network's nodes and speed up their movement.

GEAR (Geographic and Energy Aware Routing)

Restrained outflow that was of primary attention for earlier design through an investigation time frame to initiate crossways holes (few sensor are totally frazzled of source), is one of the greedy technics used by standard routing protocols to deliver data to a particular area. The Ascendable Location Updating Routing Operation uses a mechanism that has complete route knowledge, i.e., it knows the location of every sensor within the WSNs, and uses that knowledge to choose which source/end point packets should arrive at on a predetermined route [20]. Since all sensors must complete specific minimum route determination prior transmitting the data to the endpoint, the protocol uses a powerful and geographically related neighbor selection technique. The GEAR within the WSN is capable of handling average levels of data traffic. Additionally, it has the capacity to control 15 to 150 nodes, or a small WSN. The GEAR may work effectively and show enhanced results if it is utilized in scrutinizing applications like home or office watching. This resource limitations, including insufficient battery life, constrained bandwidth, and limited storage

CONCLUSION

According to the underlying network, we categorise the routing protocols in WSNs in this research as data-centric, hierarchical, and location-based. The metadata format is used by data-centric protocols to send the detected data to the BS. Data-centric routing approaches, which are those that only request specific qualities of the data, are made possible by naming the data. The sensor nodes can still be clustered for effective data transmission to the sink. By putting sensor nodes in groups, hierarchical routing protocols use the clustering strategy. Due to its tremendous scalability, this method is employed in numerous applications. Location-based protocols efficiently transport data depending on the location of sensor nodes.

REFERENCES

1. Ankur Sharma, Princy, Kirti Bhatia, Rohini Sharma, A Detailed Overview of Life Cycle Enhancing Approaches for WSN, MIDDLE EUROPEAN SCIENTIFIC BULLETIN, VOLUME 25 Jun 2022, pp. 492-499.
2. Ankur Sharma, Princy, Kirti Bhatia, Rohini Sharma, Design and Analysis of Region Centered Energy Proficient Approach for WSN, International Journal of Advanced Research in Electrical, Electronics, and Instrumentation Engineering (IJAREEIE), Volume 11, Issue 6, June 2022, pp.2616-2621.
3. Akash Bhardwaj, Kirti Bhatia, Rohini Sharma, Shalini Bhadola, Development and Analysis of Heuristic Clustering of Mobile Sensor Networks, International Journal of Innovative Research in Computer and Communication Engineering, Volume 9, Issue 8, August 2021.
4. Akash Bhardwaj, Kirti Bhatia, Rohini Sharma, Shalini Bhadola, A Deep Overview on Heuristic Algorithms for MWSN, International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET), Volume 10, Issue 8, August 2021.
5. Kamakshi, Kirti Bhatia, Shalini Bhadola, Rohini Sharma, A COMPREHENSIVE ANALYSIS OF WSN ROUTING PROTOCOLS, International Research Journal of Modernization in Engineering Technology and Science, Volume:02/Issue:08/August-2020.
6. Meenakshi, Kirti Bhatia, Shalini Bhadola, Rohini Sharma, Power Proficient Corona Deployment Strategy for Wireless Sensor Networks, IJSRD - International Journal for Scientific Research & Development|, Vol. 8, Issue 5, 2020.
7. Rohini Sharma, Impact of energy holes problem on ad-hoc routing protocols, World Review of Entrepreneurship, Management, and Sustainable Development, Vol.16 No.1, 21 Feb 2020, pp.63 – 75.
8. Sandra M. H. and Stephen T. H. A survey of gossiping and broadcasting in communication networks, Networks 1971-1995 Volume 18, Issue 4 , Pages319 – 349 Copyright © 1988 Wiley Periodicals, Inc., A Wiley Company.
9. C. Intanagonwiwat, R. Govindan and D. Estrin, (August 2000), "Directed diffusion: A scalable and robust communication paradigm for sensor networks", Proceedings of the 6th AnnualACM/IEEE International Conference on Mobile Computing and Networking (MobiCom'00), Boston, MA.
10. D. Braginsky and D. Estrin, (October 2002), "Rumor Routing Algorithm for Sensor Networks", Proceedings of the First Workshop on Sensor Networks and Applications (WSNA), Atlanta, GA.
11. N. Sadagopan et al., (May 2003), "The ACQUIRE mechanism for efficient querying in sensor networks," Proceedings of the First International Workshop on Sensor Network Protocol and Applications, Anchorage, Alaska.
12. Jabed Faruque & Ahmed Helmy, (2004), "RUGGED: Routing on Fringerprint Gradients in Sensor Networks," Pervasive Services, ICPS, IEEE/ACS International Conference.
13. Heinzelman WB, Chandrakasan AP, Balakrishnan H. (2002). An application-specific protocol architecture for wireless microsensor networks. IEEE T Wirel Commun 2002, 1: 660-70.

14. Lindsey, S. and Raghavendra, C. (2002). PEGASIS: Power-Efficient Gathering in Sensor Information Systems, in Proceedings of the IEEE Aerospace Conference, vol. 3, pp. 1125- 1130, Big Sky, MT, USA, March 2002.
15. A. Manjeshwar and D. P. Agrawal, (April 2001), "TEEN : A Protocol for Enhanced Efficiency in Wireless Sensor Networks," Proceedings of the 1st International Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile Computing, San Francisco, CA.
16. M. Younis, M. Youssef and K. Arisha, (October 2002), "Energy-Aware Routing in Cluster-Based Sensor Networks", in the Proceedings of the 10th IEEE/ACM International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS2002), Fort Worth, TX.
17. Siva D. Muruganathan, Damiel C.F.MA, Rolly I.Bhasin and Abraham O.FAPOJUWO, (March 2005), "A Centralised Energy-Efficient Routing Protocol for Wireless Sensor Networks," IEEE Radio Communication.
18. Kemal Akkaya and Mohamed Younis, (2005),"A Survey on Routing Protocol for Wireless Sensor Network", Elsevier Ad Hoc Network Journal, Vol 3/3pp. 325-549.
19. B. Karp and H. T. Kung, (August 2000), "GPSR: Greedy perimeter stateless routing for wireless sensor networks," in the Proceedings of the 6th Annual ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom '00), Boston.
20. Karp, B. and Kung., H. T. (2000). GPSR: Greedy Perimeter Stateless Routing for Wireless Networks, In Proc. ACM Mobicom, pp.: 243 – 254, ISBN:1-58113-197-6